search, any thing like the ordinary parasitic fungi. It was long ago conceded by entomologists that the disease did not arise from the depredations of insects.

I am now able to confidently assert that this devastating disease of the peach is caused by Bacteria!

These minute, moving, living things are found in great numbers within the cells of the diseased tree. They are apparently specifically different from those of the pear tree, being comparatively much more slender. What I take to be the typical form—all vary considerably—is very nearly 1 μ by 3.5 μ (.0000343 in. by .0001202 in.), made up of several not very evident articulations. They rest in some stages nearly or quite motionless. and in this condition show a curious peculiarity of lying in ranks, side by side. In other periods of development they move in an unsteady, undulating manner with considerable rapidity; they turn, twist and tumble on their sides, on end, now drifting with the current, now swarming in an inextricable maze in the field of a first-class one-tenth objective.

As the Bacteria increase the starch grains, stored by the tree for its own nourishment disappear, and I doubt not further investigation will prove that, as in the blight of the pear and apple, butyric fermentation takes place. The diseased tree probably suffers in other ways from the presence of these minute parasites, but we may say with truth that it really starves to death. Its food, gathered from the earth and air, assimilated by the leaves and stored for immediate or future use, is ruthlessly seized upon and destroyed. No doubt this takes place at all times of the year, when the temperature of the surrounding air is considerably above the freezing point; but the Bacteria are probably most active in the summer time.

Judging from my experiments upon the pear tree, the destroyers only gain entrance to the tissues of the tree through wounds in the epidermis or bark; but it is possible that at the time of flowering they penetrate by way of the stigma, which is not protected by an impervious coating.

The cellulose tissue of the tree is not destroyed, and it is still a puzzle how the Bacteria, minute as they are, pass from cell to cell. As in the pear, it is probably a very slow process, and is not connected with the circulation of fluids in the tissues.

The discovery of Bacteria as the cause of disease in plants may prove a notable contribution to the "germ theory" of disease in animals.

THE ANTIQUITY OF MAN IN EASTERN AMERICA, GEOLOGICALLY CONSIDERED.*

By HENRY CARVILL LEWIS, A. M.

In the course of an investigation of the surface geology of southeast Pennsylvania, the writer has determined some facts, regarding one of the gravels, which, bearing directly upon the antiquity of man in America, become of interest. In former papers the writer has shown that the gravels of the Delaware Valley belong to several distinct ages; and if therefore at any place the remains of man are shown to occur, it will be important to know to which of these gravels they should be referred.

The surface formations of southeast Pennsylvania may be divided into five clays and four gravels. These are, beginning with the oldest: (1) *Jurasso-cretaceous* plastic clay, seen at Turkey Hill, Bucks Co.; (2) Tertiary clays of the "*Brandon Period*," associated with the iron ore, kaolin and lignite of the Montgomery County Valley; (3) "*Bryn Mawr gravel*," often found at elevations of 400 ft., characterized by the presence of an iron conglomerate and of pebbles of Potsdam, but never of Triassic rocks, and conjectured to be late Tertiary; (4) "*Branchtown clay*" of similar age; (5) "*Glassboro' gravel*," of latest Pleiocene age, found also on the watershed in New Jersey, between the Atlantic and the Delaware, and known by its pebbles of Niagara limestone and of other fossiliferous rocks; (6) "*Philadelphia red gravel*," of Champlain age, which contains numerous boulders of all materials, fragments of Triassic rocks, etc., which shows flow-and-plunge structures and wave action on a large scale, which rests on a decomposed gneiss, and which is confined to the river valley; (7) *Philadelphia brick clay*, which, with its boulders, rests upon the last, aud like it, appears to have been deposited by the waters of the melting nort hern glacier; (8) "*Trenton gravel*," a sandy river gravel forming the bed of the Delaware; (9) the modern *alluvial mud* now forming in the tidewater swamps.

Of these formations, one of the least conspicuous at Philadelphia is that now called the Trenton gravel. It is a true river gravel, rising here but a few feet above the water, and forming a quicksand when below water level. It is of gray color, and contains pebbles composed entirely of the rocks which form the upper valley of the river. Unlike older gravels, it has very few quartz pebbles, and its pebbles are generally flat. In the middle of the river at Philadelphia it is 100 ft. deep. On tracing this gravel up the Delaware it is found to rise higher above the river and to extend farther back from it as we proceed up stream. Thus, at Bristol it extends two miles back from the river, and is bounded by a well-marked hill, upon which rest the older gravels. At Trenton, the limit of tidewater, the narrow upland portion of the valley begins; and from there up this gravel is shallow, and confined to the river bed. The oceanic gravels trend across New Jersey, and are no more seen. Two surface formations alone remain—the river gravel of past glacial age, and the brick clay, with its boulders, of champlain age. The first lies within the last, and both can be traced up to the great terminal moraine near Belvidere. It is to be especially noted that the Trenton gravel is newer than a drift of champlain age. It is in this Trenton gravel, and in this gravel only, that traces of man are found.

The Trenton gravel at the locality which gives it its name, is remarkably well exposed. Trenton is at the point where a long narrow valley with continuous downward slope opens out into a wide alluvial plain, and where the rocky floor of the river suddenly descends below ocean level. It is here that the bulk of a gravel, swept down the upper valley, would, on meeting tidewater, stop in its course, and with its boulders be heaped up in a mass, immediately afterward to be cut through by the river. It was thus that a cliff of gravel 50 ft. high was here formed, the river having cut through the gravel instead of flowing upon it, as at Philadelphia. This explanation dispenses with the necessity of assuming, as some geologists have done, the submergence of the land by the ocean at the time of the deposition of the gravel. That Southern N. J. was at that time dry land is shown by the fact that this gravel at Trenton extends inland a few miles only, and having filled up a bar in the ancient flooded river, is bounded by hills of the older gravel which forms Southern N. J.

There are many facts indicating that the Trenton gravel is a true river gravel and not a glacial moraine, which are detailed in the present paper. The absence of glacial marks on the rocks, the stratified character of the gravel, the topography of its banks, the comparative amount of its erosian and the character of its materials, all point to the conclusion that it was deposited by a great flood of the river; and this, when taken in connection with the fact that it lies within a channel cut through gravel deposited by the waters of the melting glacier indicates a past glacial and comparatively recent age of the Trenton gravel.

The important bearing of this fact upon the antiquity of man on the Delaware, which, as will appear, depends directly upon the age of this gravel, is here apparent. Calculations based upon the erosive power of running water show that the time necessary for the river to cut through this gravel down to the rock need not have been long. On the

* Read before the A. A. A. S., Boston, 1880.

other hand, no such flood as deposited this gravel has ever occurred within the historical epoch. No such large boulders are ever now carried down the river. No modern rainstorms could cause such a flood. It is difficult to assign any other cause than that of a melting glacier. Yet such a glacier could hardly be the great Northern glacier, for these gravels are much newer than those of the Champlain epoch. There is here evidence of a second and more recent glacier in the Delaware valley.

The hypothesis of a *second glacial epoch* seems to explain all the facts observed. A similar period in Europe—the reindeer period—is supported by many facts. Should such a period not be traced in America, the date of the melting glacier must be made much more recent than that generally assigned.

The relics of man which occur in the Trenton gravel, and which were first found by Dr. C. C. Abbott, are of great interest. In shape, in size, in workmanship, and in material the implements here found are quite different from those used by the Red Indian. These "palæoliths" are imbedded at various depths in undisturbed Trenton gravel. There are two points which offer strong evidence that they are as old as the gravel. The first is the fact that modern Indian implements ("neoliths"), although abundant on the surface, never occur more than a few inches below it, and are never associated with the palæoliths, which are found at depths of from five to forty feet below the surface. This fact alone argues a different age for the two classes of implements. The second fact is that, when found below the surface, the palæoliths always occur in the Trenton gravel and never in older gravels. The writer has gone over, with Dr. Abbott, much of the ground where the implements occur, and it was very interesting to find that it was only within the limits of the Trenton gravel, previously traced out by the writer, that Dr. Abbot had found implements below the surface. Here, then, is the strongest probability, even if the implements were found on the surface only, that they belonged to and were of co-eval deposition with the river gravel.

The implements found in the river gravels of Europe are of similar type, though as a rule perhaps less rude. It is of interest to find that very similar implements have been used by the Eskimos, and it is probable that that race, now living in a climate and under conditions perhaps similar to those once existing in the Delaware, may have some kinship with the pre-Indian people of this river. The occurrence of bones of arctic animals in the Trenton gravel indicates a period of cold.

All the evidence now gathered points to the fact that at the time of the Trenton gravel flood, man, in a rude state, lived upon the ancient banks of the Delaware. If future archæological work can show a connection between this people and the Eskimos, it may be appropriate to call the period of the Trenton gravel and of this palæolithic people —a period perhaps following a second glacial age—the *Eskimo period*, a name more suggestive, and derived from a higher order of beings than that which gave the name "Reindeer Period."

While others have held that the occurrence of implements in the Trenton gravel indicates the existence of man in inter-glacial or even pre-glacial times, the writer believes that the investigations here described indicate the origin of man, at a time which geologically considered, is recent. Neither in the Champlain deposits, in the morainic material of the north, or in any older gravels have undoubted traces of man been discovered.

The actual age of the Trenton gravel, and the consequent antiquity of man in the Delaware, cannot be determined by geological data alone. It is the aim of this paper to define man's antiquity in relation to geological rather than to historical events. If, in showing that the Eskimo period is the last of the geological ages, it does not necessarily follow that it is by any means recent; it must be remembered, on the other hand, that its high antiquity is not proven by the facts thus far observed.

The conclusions to which the facts seem to point are briefly summarized as follows:

1. That the Trenton gravel, the only gravel in which implements occur, is a true river deposit of post-glacial age, and the most recent of all the gravels of the Delaware valley.

2. That the palæoliths found in it really belong to and are a part of the gravel, and that they indicate the existence of man in a rude state at a time when the flooded river flowed on top of this gravel.

3. That the data obtained does not necessarily prove, geologically considered, a vast antiquity of man in Eastern America.

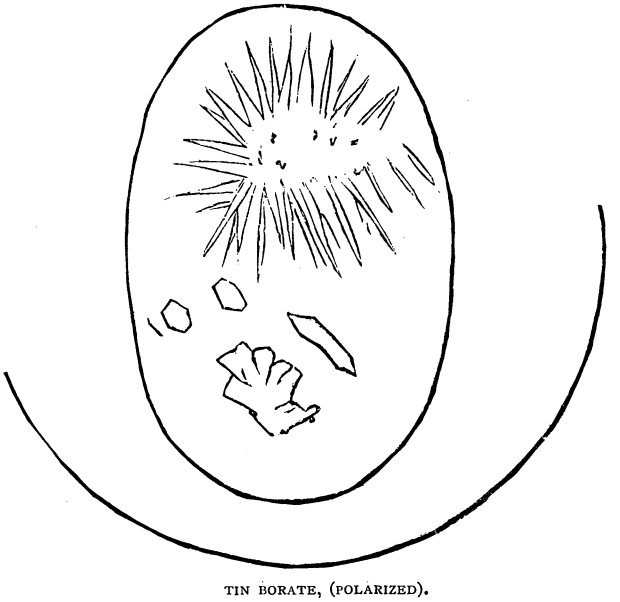
PYROLOGY, AND MICROSCOPICAL CHEMISTRY.

By W. A. Ross, Lt. Colonel, late R. A.

(1). In the year 1869, at Simla, India, having applied a trace of oxide of cobalt to a bead of boric acid before the blowpipe, I observed that, instead of dissolving, as I had been led to expect, small round black spots were formed, which, appearing perfectly round through the clear bead from every point of view, seemed to be spherides or balls. It was afterwards found that 14 oxides form such balls in boric acid, B. B., among which the most useful pyrological was that of *calcium*.

(2). I found, by the average of five assays, that the weight of the calcium borate ball, extracted by boiling water in which it is utterly insoluble, while the containing bead is rapidly dissolved—was a *constant multiple* of the weight of the calcined lime taken to make it, and that this multiple was 4.5. Thus, if w = the weight of the ball, the formula $\frac{w}{4.5}$ represented the quantity of pure lime in it. If *calcium hydrate* was taken, instead of calcined lime, a clear ball was still formed within the bead, which latter became opaque through opalescence, and as the balance showed that this ball also contained the above mentioned proportion of calcined lime, the opalescence was attributed to chemical water.

(3). Circumstances of a painful nature, which I need not here relate, prevented my going further into this matter for eight years, but I vainly solicited the Microscopical Society to take it up, and having been enabled this year (about two months ago) to purchase a binocular microscope, with polariscopic apparatus attached, I fitted a small spectroscope I had by me into one of its eye-pieces with cotton wool, etc., and renewed my examination of these boric acid balls.



TIN BORATE, (POLARIZED).

(4). Notwithstanding the undoubtedly chemical nature of the combination I have called "a calcium borate ball," the phenomenon of ball formation itself is obviously as much related to the subject of molecular physics as to chemistry, and seems explainable briefly as follows: All liquids having cohesion have, under circumstances of equilibrium,